CLAIMS:

1. A system for generating X-rays, the system comprising:

a high repetition rate laser adapted to direct high-energy optical pulses in a first direction in a laser cavity; and

a source of a pulsed electron beam adapted to direct electron beam in a second direction opposite to the first direction in the laser cavity, the electron beam impacting photons in the optical pulses in the laser cavity to produce X-rays in the second direction.

2. The system of claim 1, further comprising a plurality of mirrors located in the laser cavity for confining the optical pulses within the laser cavity.

3. The system of claim 2, wherein the plurality of mirrors are arranged in a ring configuration.

4. The system of claim 1, further comprising an isolator located in the laser cavity for directing the optical pulses in the first direction.

5. The system of claim 1, wherein the high energy optical pulses comprise high repetition rate, mode-locked optical pulses.

6. The system of claim 5, further comprising an acousto-optic cell located in the laser cavity for generating the high repetition rate, mode-locked optical pulses.

7. The system of claim 5, further comprising an electro-optic cell and a Brewster plate located in the laser cavity for generating the high repetition rate, mode-locked optical pulses.

8. The system of claim 1, further comprising a solid state laser rod located in the laser cavity for generating the optical pulses.

9. The system of claim 8, wherein the solid state laser rod is a Yb:YAG laser rod.

10. The system of claim 1, further comprising a grating located in the laser cavity for temporally stretching the optical pulses.

11. The system of claim 1, further comprising a grating located in the laser cavity for temporally compressing the optical pulses.

12. The system of claim 1, wherein the source of a pulsed electron beam is a radio frequency linear accelerator.

13. The system of claim 1, further comprising one or more magnets to direct the electron beam in the second direction in the laser cavity.

14. The system of claim 1, further comprising one or more Bragg reflectors to direct the X-rays in a pre-determined direction from the laser cavity.

15. A system for generating X-rays, the system comprising:

a mode-locked laser adapted to direct high-energy optical pulses in a first direction in a laser cavity; and

a source of a pulsed electron beam adapted to direct electron beam in a second direction opposite to the first direction in the laser cavity, the electron beam impacting photons in the optical pulses in the laser cavity to produce X-rays in the second direction.

16. The system of claim 15, further comprising an isolator located in the laser cavity for directing the optical pulses in the first direction.

17. The system of claim 15, wherein the high energy optical pulses comprise high repetition rate, mode-locked optical pulses.

18. The system of claim 17, further comprising an acousto-optic cell located in the laser cavity for generating the high repetition rate, mode-locked optical pulses.

19. The system of claim 17, further comprising an electro-optic cell and a Brewster plate located in the laser cavity for generating the high repetition rate, mode-locked optical pulses.

20. The system of claim 15, wherein the source of a pulsed electron beam is a radio frequency linear accelerator.

21. The system of claim 15, further comprising one or more magnets to direct the electron beam in the second direction opposite to the first direction in the laser cavity.

22. A system for generating X-rays, the system comprising:

a mode-locked laser adapted to generate high-energy optical pulses in a laser cavity having a ring configuration, the laser including an isolator for directing the optical pulses in a first direction; and

a source of a pulsed electron beam adapted to direct electron beam in a second direction opposite to the first direction in the laser cavity, the electron beam impacting photons in the optical pulses in the laser cavity to produce X-rays in the second direction.

23. The system of claim 22, wherein the high energy optical pulses comprise high repetition rate, mode-locked optical pulses.

24. The system of claim 23, further comprising an acousto-optic cell located in the laser cavity for generating the high repetition rate, mode-locked optical pulses.

25. The system of claim 23, further comprising an electro-optic cell and a Brewster plate located in the laser cavity for the generating high repetition rate, mode-locked optical pulses.

26. The system of claim 22, wherein the source of a pulsed electron beam is a radio frequency linear accelerator.

27. The system of claim 22, further comprising one or more magnets to direct the electron beam in the second direction opposite to the first direction in the laser cavity.

28. A system for generating X-rays, the system comprising:

a mode-locked laser adapted to direct high-energy optical pulses in a first direction in a laser cavity;

a source of a pulsed electron beam adapted to feed electron beam in an electron storage ring overlapping the laser cavity, the electron storage ring adapted to circulate electron beam in a second direction opposite to the first direction in the laser cavity, the electron beam impacting photons in the optical pulses in the laser cavity to produce X-rays in the second direction.

29. The system of claim 28, further comprising an isolator located in the laser cavity for directing the optical pulses in the first direction.

30. The system of claim 28, wherein the high energy optical pulses comprise high repetition rate, mode-locked optical pulses.

31. The system of claim 30, further comprising an acousto-optic cell located in the laser cavity for generating the high repetition rate, mode-locked optical pulses.

32. The system of claim 30, further comprising an electro-optic cell and a Brewster plate located in the laser cavity for generating the high repetition rate, mode-locked optical pulses.

33. The system of claim 28, wherein the source of a pulsed electron beam is a radio frequency linear accelerator.

34. The system of claim 28, wherein the electron storage ring is adapted to store and circulate the electron beam.

35. The system of claim 28, wherein a round trip circulation time of the electron beam in the electron storage ring is substantially equivalent to a round trip time of the optical pulses in the laser cavity.

36. The system of claim 28, wherein the electron storage ring further includes an amplifier to accelerate the electron beam circulating in the electron storage ring.

37. A system for generating X-rays, the system comprising:

a mode-locked laser adapted to generate high-energy optical pulses in a laser cavity having a ring configuration, the laser including an isolator for directing the optical pulses in a first direction;

a source of a pulsed electron beam adapted to feed electron beam in an electron storage ring overlapping the laser cavity, the electron storage ring adapted to circulate electron beam in a second direction opposite to the first direction in the laser cavity, the electron beam impacting photons in the optical pulses in the laser cavity to produce X-rays in the second direction.

38. The system of claim 37, wherein the high energy optical pulses comprise high repetition rate, mode-locked optical pulses.

39. The system of claim 38, further comprising an acousto-optic cell located in the laser cavity for generating the high repetition rate, mode-locked optical pulses.

40. The system of claim 38, further comprising an electro-optic cell and a Brewster plate located in the laser cavity for generating the high repetition rate, mode-locked optical pulses.

41. The system of claim 37, wherein the source of a pulsed electron beam is a radio frequency linear accelerator.

42. The system of claim 37, wherein the electron storage ring is adapted to store and circulate the electron beam.

43. The system of claim 37, wherein a round trip circulation time of the electron beam in the electron storage ring is substantially equivalent to a round trip time of the optical pulses in the laser cavity.

44. The system of claim 37, wherein the electron storage ring further includes an amplifier to accelerate the electron beam circulating in the electron storage ring.

45. A method for generating X-rays, the method comprising:

generating high-energy optical pulses in a laser cavity via a high repetition rate laser, the optical pulses being directed in a first direction;

generating electron beam; and

directing the electron beam into the laser cavity in a second direction opposite to the first direction, photons in the optical pulses impacting the electron beam to generate X-rays in the second direction.

46. The method of claim 45, further comprising confining the optical pulses within the laser cavity via a plurality of mirrors located in the laser cavity.

47. The system of claim 45, wherein the high energy optical pulses comprise high repetition rate, mode-locked optical pulses.

48. The method of claim 47, further comprising generating the high repetition rate, mode-locked optical pulses via an acousto-optic cell located in the laser cavity.

49. The method of claim 47, further comprising generating the high repetition rate, mode-locked optical pulses via an electro-optic cell and a Brewster plate located in the laser cavity.

50. The method of claim 45, further comprising temporally stretching the optical pulses via a grating located in the laser cavity.

51. The method of claim 45, further comprising temporally compressing the optical pulses via a grating located in the laser cavity.